Earthquake Analysis Using

Seismic Coefficient Method

EARTH QUAKE ANALYSIS USING SEISMIC COEFFICIENT METHOD:
Seismic Coefficient method is applicable for buildings:

(a) Regular Buildings :
Height < 90m in zones II & III.
<40m in zones IV & V

(b) Irregular Buildings :
Height < 40m in zones II & III.
<12m in zones IV & V

The Various methods used in STAAD Pro for earthquake analysis are:

1. Lumped mass method (introduced by Research Engineers before 2007)
2. Member weight method (Introduced by Bentley after 2007)
3. Reference load method (Introduced by Bentley after 2007)
4. Converting static load to equivalent seismic analysis .

Design of seismic shear (V_B)

Total design seismic base shear V_B along any principal direction is given by

$V_B = A_h W$

A_h= Design horizontal acceleration spectrum value

$A_h = (Z/2)(I/R)(Sa/g)$

W= Seismic weight of building
= Dead load + appropriate amount of imposed load.

Note:

1. Live load upto and including 3.0 KN/m^2 =25% of imposed load.
2. Live load > 3.0KN/m^2 = 50% of imposed load.
3. For calculating design seismic forces imposed load on roof need not be considered.

Applying Seismic in STAAD Pro :

There are two parts.
Part 1: Define Seismic load.
Part 2: Applying Defined Seismic Load

Part 1 : Define Seismic Load

The value of A_h is computed by generating Seismic Load Definition by specifying

following parameters in STAAD.
Main menu →Commands→Loading→Definitions→Seismic Load→IS1893-2002→
(OR)
Click Load and Definitions→Click Definitions→Seismic Load→Add.
Seismic parameter screen will appear. Select Type: IS1893-2002→Click Generate→Add.

Select city or zone: (Table 2 of IS 1893-2002)

Seismic zone	II	III	IV	V
Seismic intensity	Low	Moderate	Severe	Very Severe
Zone factor	0.10	0.16	0.24	0.36

Response Reduction Factor (RF) : (Table 7 of IS 1893-2002)

5 for Special Moment Resistance Frame (SMRF)

3 for Ordinary Moment Resistance Frame (OMRF)

Important Factor (I) : (Table 6 of IS 1893-2002)

1 for ordinary Residential building

1.5 for Important Building

Rock or Soil sites Factor (SS): Clause 6.4.5 of IS 1893-2002)

1 for hard soil (N> 30)

2 for Medium soil (10< N < 30)

3 for soft soil (N< 10)

Type of structure (ST) (optional): (Clause 7.6 of IS 1893-2002)

1 for RCC Frame Building

2 for Steel Frame Building

3 for all other Building

Damping ratio (DM): (Table 3 of IS 1893-2002)

0.05% for concrete.

PX= Period in X direction : (Optional)

PZ= Period in Z direction : (Optional)

The approximate fundamental natural period of vibration in seconds for

RC Frame buildings without brick in- fills $T=0.075\ h^{0.75}$

For all other buildings including frame buildings with brick in-fills $T_x = \frac{0.09\ h}{\sqrt{d_x}}$

d_x = dimension in X direction.

$T_z = \frac{0.09\ h}{\sqrt{d_z}}$

d_z = dimension in X direction.
h = height of building in metre
d= base dimension at plinth in metre along the direction of force.
Depth of Foundation (DT): (For under ground structures)
Click Generate → Add→ Close.

To calculate Seismic weight of building (w):

Click Z 0.16 RF 3 I 1.5 SS 2 ST 1 DM 0.05 → Add.

Seismic Definitions screen will appear.

Click self weight → self weight 1 → Add.

Click member weight→ Loading type: UNI weight: 12 KN/m (for external wall)

6 KN/m (for internal wall) → Add.

Click Floor weight → Pressure : 4 KN/m^2 (dead load)

Y range: Mini: 3.0m Max: 15.0m→ Add.

Floor weight→ Pressure : 0.50KN/m^2 (appropriate Live load) → Add.

Y range: Mini=3.0m Max=12.0m (except roof slab) → Add→ Close.

Note:

1. W= Seismic weight of Building= Dead load+ appropriate amount of imposed load. Live load up to and including 3.0KN/m^2 =0.25% of imposed load.
   Live load > 3.0KN/m^2 =50% of imposed load.
   For calculating design seismic forces imposed load in roof need not be considered.

Click self weight →⊙ select to view →Assign.

Click Member weight → Main menu → Select→ Beam parallel to → X and Beam

parallel to → Z → ⊙ Assign to selected beam → Assign→Yes→ Close.

2. In seismic analyses always first load case shall be seismic load only.

Part 2: Applying defined Seismic Load :
Click Load case details → Add.
Member 1 Loading type: Seismic

Title: Seismic in X +ve → Add.
Number 2 loading Type: Seismic
Title : Seismic in X –ve → Add.
Number 3 loading Type: Seismic
Title : Seismic in Z +ve → Add.
Number 4 loading Type: Seismic
Title : Seismic in Z –ve → Add → close.
Highlight seismic in X +ve→ Add.
Seismic load ⊙ X direction Factor=1 → Add.
Highlight seismic in X -ve→ Add.
Seismic load ⊙ X direction Factor=-1 → Add.
Highlight seismic in Z +ve→ Add.
Seismic load ⊙ Z direction Factor=1 → Add.
Highlight seismic in Z +ve→ Add.
Seismic load ⊙ Z direction Factor=-1 → Add →Close.
Load combination to be considered in case of Seismic

1. For Superstructure (Ultimate load condition)
    1. 1.5 (DL+LL)
    2. 1.5 (DL+ S in X +ve)
    3. 1.5(DL+ S in X –ve)
    4. 1.5 (DL+ S in Z +ve)
    5. 1.5 (DL+ S in Z –ve)
    6. 1.2(DL+LL+ S in X+ve)
    7. 1.2(DL+LL+ S in X-ve)
    8. 1.2(DL+LL+ S in Z+ve)
    9. 1.2(DL+LL+ S in Z-ve)
    10. 0.9DL+ 1.5 S in X +ve
    11. 0.9DL +1.5 S in X-ve
    12. 0.9DL+ 1.5 S in Z+ve
    13. 0.9DL + 1.5 S in Z-ve.

2. For Sub structure (Service load condition)
    1. (DL+LL)
    2. DL+ S in X+ve
    3. DL + S in X-ve
    4. DL + S in Z +ve
    5. DL + S in Z –ve
    6. DL+0.8LL+ S in X +ve
    7. DL+0.8LL+ S in X –ve
    8. DL+0.8LL+ S in Z+ve
    9. DL+0.8LL+ S in Z-ve